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Influence of foliar nutrients and plant growth regulators on growth and yield of strawberry (*Fragaria* × *ananassa* Duch.) under naturally ventilated polyhouse

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Abstract

A pot experiment was conducted to study the influence of foliar nutrients and plant growth regulators on growth and yield of Strawberry (*Fragaria* × *ananassa* Duch.) under naturally ventilated polyhouse. The experiment was laid out in Completely Randomized Design with eleven treatments and three replications. Results of the study revealed that the application of GA_3 150 ppm (T_9) showed maximum plant height (19.21 cm), plant spread in north-south and east-west direction (28.15 cm and 24.79 cm respectively.), number of trifoliate leaves (25.20), maximum number of crowns per plant (4.93), leaf area (127.78 cm^2) and leaf area index (3.94), maximum number of runners per plant (5.29), minimum number of days taken for flowering (85.81 days), highest number of flowers (28.00) and fruits per plant (19.08), maximum yield per plant (299.36 g). Application of boron 0.6 per cent (T_7) showed maximum fruit length (4.18 cm), fruit diameter (3.90 cm), fruit circumference (11.15 cm), maximum fruit weight (17.22 g) and fruit volume (21.78 cc).

Keywords: Strawberry, winter dawn, growth, yield

Introduction

Strawberry (*Fragaria* × *ananassa* Duch.) is the most delicious and refreshing fruit. It is cherished in the garden for its beautiful red berries that has a tantalizing aroma. The fruits are widely acclaimed for its pleasant flavor, conspicuous colour and varied blend of taste. All cultivated varieties of strawberry are octaploid (2n = 56) in nature and belongs to the family Rosaceae. It is a short day plant, originated from France and the two American diploids *Fragaria chiloensis* and *Fragaria virginiana* are considered as its progenitors (Staudt, 1989) [8]. Strawberries are in great demand for fresh market and its popularity can be judged by the phenomenal increase in yield due to the changes in production pattern like intensive cultivation system, adoption of day neutral cultivars and choice of appropriate environment. Foliar application of the nutrients is obviously an ideal way of evading the problems of nutrient availability and a common practice to overcome the nutrients deficiencies, strengthens damaged crops, speeds up growth and increases yield and quality of fruit.

Pre-harvest application of calcium have been practised commercially in strawberry for improving quality, reducing postharvest decay and controlling the physiological disorders (Poovaiah, 1986) [14]. Foliar applications of calcium during the growing season has been reported to delay ripening and mould development in strawberries (Cheour *et al*., 1991; Chung *et al*., 1995) [7, 8]. Boron plays major role in translocation of sugar and reproduction and another important micronutrient is zinc which is important component of many enzymes and it is an essential metal for normal plant growth and development and required for the synthesis of tryptophan, a precursor of IAA which acts as a growth promoting substance. Foliar application of growth regulators has been practiced commercially to increase the production of strawberry. These growth regulators excite the natural plant hormones and allow synchronization of plant development to occur. Plant growth regulators (PGRs) have proven their role in augmenting yield and quality in many fruits. PGRs are either synthetic or natural compounds that modifies plant physiological processes at very minute concentrations. By considering this points, an experiment was conducted to study the influence of foliar nutrients and plant growth regulators on growth and yield of strawberry under naturally ventilated polyhouse.

Materials and Methods

The experiment was carried out in low cost naturally ventilated polyhouse at the Department of Fruit Science, College of Horticulture, Mudigere, situated in Western Ghats in the Hilly Zone (Zone 9 and Region V) of Karnataka during 2018-2019. It is located at 13°25' North latitude and 75°25' East longitude with an altitude of 982 m above mean sea level. The experiment was conducted by adopting Completely Randomized Design with three replication and eleven treatments (T_1 - Control, T_2 - Calcium nitrate (0.4%), T_3 - Calcium nitrate (0.6%), T_4 - Zinc sulphate (0.4%), T_5 - Zinc sulphate (0.6%), T_6 - Boron (0.4%), T_7 - Boron (0.6%), T_8 - Gibberellic acid (100 ppm), T_9 - Gibberellic acid (150 ppm), T_{10} - Naphthalene acetic acid (25 ppm), T_{11}- Naphthalene acetic acid (50 ppm)). The experiment was conducted on winter dawn cultivar of strawberry. The experiment was carried out in the plastic pots of 10 inch height. They were filled with thoroughly mixed potting mixture (soil: sand: FYM in 2:1:1). Thereafter, trichoderma (1 g / kg of media) was added to avoid diseases and then the filled pots were left for 3 weeks. Transplanting was done on 1st of November 2018 in the evening hours for good establishment. Two concentrations of different foliar nutrients along with control (water spray) were considered as various treatments. And RDF @ 150:100:120 kg / ha is common for all the treatments. The experimental pots were kept clean by hand weeding. Irrigation was given through rose can regularly throughout the period of crop growth to maintain uniform moisture. Different concentrations of zinc sulphate, calcium nitrate and boron solutions as per the treatment were prepared and applied at 25, 50, 75 and 100 days after transplanting. The growth and yield components were taken and subjected to statistical analysis.

Results and discussion

I. Morphological parameters: Morphological parameters of strawberry (Table 1) as influenced by foliar nutrients and growth regulators were found to differ significantly due to the treatment effect.

1.1 Plant height

The results of the study revealed that the maximum plant height (19.21 cm) was observed in GA_3 150 ppm (T_9) and the minimum plant height was observed in Control (T_1) 13.94 cm at 100 days after transplanting. The maximum increase in plant height might be due to the fact that gibberellins regulated the growth of strawberry plants by causing cell elongation and increased cell division. This might also be due to the fact that gibberellins cause the elongation in internodal length. The research findings of Dubey *et al.* (2017) [10] and Paikra *et al*. (2018) [12] in strawberry are in support with the present findings.

1.2. Plant spread

Significant difference was observed with respect to plant spread in both north-south and east-west direction. The maximum plant spread in north-south direction was recorded in GA_3 (150 ppm) *i.e.,* T_9 (28.15 cm at 100 Days after transplanting) and minimum was recorded in control (T_1) (18.22 cm at 100 Days after transplanting). Whereas, maximum plant spread in east-west direction was recorded in T_9 (24.79 cm at 100 days after transplanting) and minimum was recorded in T_1 (15.73 cm at 100 Days after transplanting). The increase in plant spread could be attributed to increased length and upright growth of leaf petioles which lean outwards resulting in higher plant spread. The research result is in conformity to the findings of Singh and Tripathi (2010) [17] and Rajesh *et al.* (2012a) [15].

1.3 Number of trifoliate leaves per plant

The number of leaves per plant differed significantly at all the stages of crop growth except 30 days after planting due to the influence of various treatments. The maximum number of trifoliate leaves (25.20 at 100 Days after transplanting) was observed in GA_3 150 ppm (T_9). The minimum number of trifoliate leaves per plant was observed in control *i.e.,* T_1 (20.16 at 100 Days after transplanting). The increase in number of leaves may be due to the corresponding increase in length of epidermal and parenchyma cells, higher rate of cell division and cell elongation in sub-apical meristems of strawberry shoots which might lead to production of higher number of leaves. The research findings are in line with the results obtained by Uddin *et al*. (2012) [20] and Khalid *et al.* (2013) [11] in strawberry crop.

1.4 Number of crowns per plant

The maximum number of crowns per plant was recorded in GA_3 150 ppm *i.e.,* T_9 (4.93). The minimum values were recorded in control *i.e.,* T_1 (2.11), the above values were recorded at 100 days after transplanting. The increase in number of crowns per plant was due to increase in cell number and cell elongation. The results are in conformity with Singh and Tripathi (2010) [17] and Ali *et al.* (2011) [3] in strawberry plant.

1.5 Leaf area and leaf area index

The leaf area and leaf area index differed significantly between the treatments at all stages of crop growth. The treatment T_9 (GA_3 150 ppm) produced maximum leaf area (127.78 cm^2) which was on par with T_8 (124.15 cm^2) and leaf area index (3.94) which was found to be on par with T_8 (3.49) at 100 days after transplanting. Whereas both leaf area (100.83 cm^2 at 100 days after transplanting) and leaf area index (2.26 at 100 days after transplanting) were found minimum with T_1 (control).

The significant increase in leaf area and leaf area index might be due to increased length of epidermal, parenchyma cells and also increases the rate of cell division which in turn results in increased leaf length and breadth resulting in larger leaf surface area. These results are in conformity with the findings of Akath and Singh (2009) [2], Rajesh (2012a) [15], and Saima *et al*. (2014) [16] in strawberry crop.

1.6 Number of runners per plant

The maximum number of runners per plant (5.29) was recorded in T_9 (GA_3 150 ppm) and it was on par with T_8 (5.07) whereas, minimum (2.93) was recorded in T_1 (control). This might be due to the fact that application of gibberellin increases the vegetative growth *viz.*, number of leaves, crown and leaf area which facilitates accumulation of more photosynthates leading to production of more number of runners per plant. This is in conformity with the findings of Braun and Kender (1985) [6], Adams *et al.* (1975) [1], Singh and Tripathi (2010) [17], and Paikra *et al*. (2018) [12] in strawberry crop.

2. Yield Parameters of Strawberry: Reproductive parameters as influenced by various treatments are depicted below (Table 2)

2.1 Number of days taken for flowering

Significant difference for number of days taken for flowering was found among various treatments. The minimum number of days taken for flowering (85.81 days) was recorded in T_9 (GA_3 150 ppm) and the highest number of days taken for flowering (100.23 days) was recorded in T_1 (control). This could be attributed to the fact that gibberellins is responsible for vigorous growth of plant in all vegetative stages, where they can store sufficient amount of photosynthates for producing more number of flowers. And also known to overcome endogenous dormancy factors and promotes flowering by causing rapid growth of flower primordia. This results are in conformity with Phatak and Singh (1979) [13], Tripathi and Shukla (2006) [19], Asadi *et al.* (2013) [4] in strawberry.

2.2 Number of flowers and fruits per plant

It is evident from the data that significantly higher number of flowers (28.00) and fruits per plant (19.08) was recorded in the plants treated with in GA_3 150 ppm (T_9) and the minimum number of flowers (20.84) and fruits per plant (14.30) was observed in T_1 (control). Highest number of flowers and fruits per plant was due to the fact that gibberellins causes the production of large number of flowers with rapid elongation of peduncle, leading to full development of flower buds having all reproductive parts functional thereby accelerates development of differentiated inflorescence, which increases fruit set and number of berries per plant. The research results are in line with the findings of Phatak and Singh (1979) [13], Tripathi and Shukla (2006) [19] and Paikra *et al.* (2018) [12] in strawberry crop.

2.3 Length, diameter and circumference of fruit

Significantly maximum length (4.18 cm), diameter (3.90 cm) and circumference (11.15 cm) of strawberry fruits were recorded in T_7 (boron 0.6%) whereas, minimum length (2.98 cm), diameter (2.43 cm) and circumference (6.65 cm) of fruits were observed in T_1 (control).

The increased parameters with the application of boron might be due to greater translocation of photosynthates to the berries. This could be due to the role of boron in plant metabolism (Dixit *et al.*, 2013) [9] in terms of better pollination, supply of water, nutrients and other compounds vital for the proper growth and development of fruits.

2.4 Fruit weight and fruit volume

Among different treatments, plants sprayed with boron 0.6 per cent (T_7) was recorded maximum fruit weight (17.22 g) and fruit volume (21.78 cc). While, minimum fruit weight (12.13 g) and volume (16.50 cc) was found with T_1 (control). The increase in weight and volume of fruits with the application of boron could be attributed to effective pollination and the development of viable seeds which in turn affect the normal development of fruit and also its role in transportation of higher amount of assimilates to fruit is the evidence for increase in above parameters. The current results are in accordance with the findings of Bakshi *et al*. (2013) [5] in strawberry crop.

2.5 Yield per plant

Application of different growth regulators and nutrients resulted in significant variations in yield per plant between the different treatments. The maximum yield per plant (299.36 g) was recorded in T_9 (GA_3 150 ppm) followed by T_8 (283.87 g), T_7 (274.31 g) and minimum (173.45 g) was recorded in T_1 (control).

This increase in fruit yield per plant in gibberellins treated plants might be due to increased vegetative growth (plant spread, number of crowns and leaves etc.) which enables higher fruit set and fruit weight. The yield attributes on the sink capacity of crop is determined by its vegetative growth throughout the life cycle of plants. Vigorous growth is associated with higher sink capacity of a crop. The higher yield might be also related to formation of more metabolites by large leaves and high rate of photosynthesis. This result is in conformity with the findings of Tripathi and Shukla (2006) [19] and Saima *et al.* (2014) [16] in strawberry crop.

In conclusion, results obtained in the present investigation shows that foliar application of GA_3 (150 ppm) has shown better growth and maximum yield ratio in strawberry followed by GA_3 (100 ppm).

Table 1: Effect of foliar nutrients and plant growth regulators on growth parameters of strawberry

Treatments	Plant height (cm)	Plant spread (cm)		No. of trifoliate leaves per plant	Leaf area (cm^2)	Leaf area index	No. of crowns	No. of runners
		N-S	E-W					
T_1	13.94	18.22	15.73	20.16	100.83	2.26	2.11	2.93
T_2	13.98	18.95	17.34	21.30	104.30	2.57	3.67	3.94
T_3	15.09	21.52	18.36	22.03	112.45	2.76	3.96	3.96
T_4	16.82	20.50	18.22	22.12	107.20	2.42	3.32	3.44
T_5	15.71	22.37	19.40	23.01	116.54	2.55	3.58	3.86
T_6	15.77	19.56	16.54	21.02	106.20	2.28	2.88	3.43
T_7	15.84	18.52	17.73	22.00	106.21	2.31	3.19	3.62
T_8	18.14	25.35	22.24	24.59	124.15	3.49	4.34	5.07
T_9	19.21	28.15	24.79	25.20	127.78	3.94	4.93	5.29
T_{10}	17.06	21.66	18.80	21.69	109.45	2.58	3.81	4.02
T_{11}	15.71	24.28	19.69	22.46	118.17	3.04	4.24	4.04
S. Em ±	0.36	0.61	0.53	0.43	3.13	0.05	0.05	0.10
C. D. (P = 0.05)	1.06	1.82	1.57	1.28	9.11	0.15	0.15	0.29

Table 2: Effect of foliar nutrients and plant growth regulators on yield parameters of strawberry

Treatments	Number of days taken for first flowering	Number of flowers per plant	Number of fruits per plant	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit volume (cc)	Fruit circumference (cm)	Yield/ plant (g)
T_1	100.23	20.84	14.30	12.13	2.98	2.43	16.50	6.65	173.45
T_2	96.28	23.40	17.02	12.87	3.30	2.76	16.69	7.15	219.04
T_3	96.54	23.46	16.07	13.97	3.55	3.09	17.50	7.84	224.49
T_4	94.10	21.80	15.96	14.03	3.83	3.12	19.36	8.42	223.91
T_5	93.20	22.14	15.27	14.92	3.87	3.14	19.71	8.75	227.82
T_6	97.18	22.28	15.16	16.82	4.13	3.81	21.69	10.98	271.81
T_7	95.09	21.66	15.93	17.22	4.18	3.90	21.78	11.15	274.31
T_8	89.74	26.20	18.95	14.98	3.90	3.70	19.88	10.06	283.87
T_9	85.81	28.00	19.08	15.69	3.96	3.78	20.11	10.22	299.36
T_{10}	92.50	24.46	17.90	13.75	3.89	3.20	19.90	9.13	246.12
T_{11}	91.53	25.66	17.55	13.95	3.86	3.22	20.32	9.21	244.82
S. Em ±	1.24	0.57	0.35	0.38	0.09	0.04	0.47	0.21	4.33
C. D. (P = 0.05)	3.70	1.70	1.04	1.12	0.27	0.10	1.40	0.61	12.96

References

1. Adams PA, Montague MJ, Tepfer M, Rayle DL, Ikuma H, Kaufman PB. Effect of gibberellic acid on the plasticity and elasticity of Avena stem segments. Indian J. Plt. Physiol. 1975; 56:757-760.
2. Akath S, Singh JN. Effect of bio fertilizers and bio regulators on growth and nutrient status of strawberry cv. Sweet Charlie. Indian J. Hort. 2009; 66(2):220-224.
3. Ali M, Toktam ST, Shokofeh M. Effects of benzyladenine and gibberellins on runner production and some vegetative traits of three Strawberry cultivars. African J. Agric. Res. 2011; 6(18):4357-4361.
4. Asadi Z, Jafarpour M, Golparvar AR, Mohammadkhani A. Effect of GA_3 application on fruit yield, flowering and vegetative characteristics on early yield of strawberry cv. Gaviota. Int. J. Agri. Crop Sci. 2013; 5(15):1716-1718.
5. Bakshi P, Jasrotia M, Wali VK, Sharma A, Bakshi M. Influence of pre-harvest application of calcium and micro-nutrients on growth, yield, quality and shelf-life of strawberry cv Chandler. Indian J Agr. Sci. 2013; 83(8):831-835.
6. Braun JW, Kender W. Correlative bud inhibition and growth habit of the strawberry as influenced by application of gibberellic acid, cytokinin and chilling during short-day length. J Am. Soc. Hortic. Sci. 1985; 110:28-34.
7. Cheour F, Willemot C, Arul J, Makhlouf J. Desjardins, Y. Postharvest response of two strawberry cultivars to foliar application of $CaCl_2$. Hort Sci. 1991; 26(9):1186-1188.
8. Chung HD, Kang KY, Yun SJ, Kim BY. Effect of foliar application of calcium chloride on shelf-life and quality of strawberry fruits. Horticultural Abstracts. 1995; 65:143.
9. Dixit A, Shaw SS, Pal V. Effect of micronutrients and plant growth regulators on fruiting of litchi. Hort. Flora Research Spectrum. 2013; 2(1):77-80.
10. Dubey VML, Meena VK, Tripathi DC, Meena, Kumar J, Tribhuvanrai. Response of foliar application of NAA, GA_3 and Boric acid on vegetative growth and yield of strawberry (*Fragaria* × *ananassa* Duch) cv. Chandler. Ann. Hortic. 2017; 10(1):40-44.
11. Khalid MQ, Saman C, Usman SQ, Nadeem AA. Impact of exogenous application of salt and growth regulators on growth and yield of strawberry. Pakistan J Bot. 2013; 45(4):1179-1185.
12. Paikra, Panigrahi HK, Sharma GL, Chandrakar S. Effect of foliar spray of different PGRs on growth parameters, flowering, fruiting and fruit maturity of strawberry (*Fragaria* × *ananassa* Duch.) cv. Sabrina under net tunnel. Int. J Chem. Stud. 2018; 6(6):299-302.
13. Phatak RK, Singh R. Effect of GA_3 and growth retardants on vegetative growth of Strawberry. Indian J Hort. 1979; 25:43-45.
14. Poovaiah IB. Role of calcium in prolonging storage life of fruits and vegetables. Food Technol. 1986; 40:86-89.
15. Rajesh K, Manish B, Singh DB. Influence of plant growth regulators on growth, yield and quality of Strawberry (*Fragaria* × *ananassa* Duch.) under U. P. sub tropics. The Asian J Hort. 2012a; 7(2):434-436.
16. Saima Z, Sharma A, Umar I, Wali VK. Effect of plant bio- regulators on vegetative growth, yield and quality of Strawberry cv. Chandler. African J Agric. Res. 2014; 9(22):1694-1699.
17. Singh VK, Tripati VK. Efficacy of GA_3, boric acid and $ZnSO_4$ on growth, flowering and yield and quality of strawberry. Prog. Agric. 2010; 10(2):345-348.
18. Staudt G, The species of *Fragaria*, their taxonomy and geographical distribution. Acta Hortic. 1989; 265:23-33.
19. Tripathi VK, Shukla PK. Effect of plant bio-regulators on growth, yield and quality of Strawberry cv. Chandler. J Asian Hort. 2006; 2(4):260-263.
20. Uddin AFM, Hossan MJ, Islam MS, Ahsan MK, Mehraj H. Strawberry growth and yield responses to gibberellic acid concentrations. J Expt. Biosci. 2012; 3(2):51-56.